

Global Tropospheric Experiment Amazon Boundary Layer Expedition 2B (ABLE 2B) Langley ASDC Data Set Document



Summary

This document provides information on data products obtained during the GTE ABLE 2B atmospheric science expedition conducted over the Amazon during April-May, 1987. The objective of the mission was to obtain a quantitative chemical characterization of the temporal and spatial variability of trace gases and aerosols over the Amazon during the wet season. Measurements were made primarily by investigators' instruments located on the NASA Wallops Electra airborne laboratory. Also provided are a list of principal investigators, a brief summary of measurement techniques and a list of publications.

This document provides information for the following five data sets:

- GTE_A2B_Elec_Chem
- GTE_A2B_Tower
- GTE_A2B_Rawinsondes
- GTE_A2B_Balloons
- GTE_A2B_Merged_Data

Acknowledgment

NASA funded the investigators involved in the ABLE 2B mission. The funded investigators, their organization and grant, agreement or contract number were:

Area	Investigator	Organization	Grant
Aircraft	M. O. Andreae	Florida State U	NAG-1-588
	S. M. Beck	NASA Langley	N/A
	Edward Browell	NASA Langley	N/A
	M. Garstang	U of Virginia	NCC-1-95
	Gerald Gregory	NASA Langley	N/A
	R. C. Harriss	U of New Hampshire	NAG-1-1014
	R. A. Rasmussen	Oregon Grad Ctr	N/A
	Glen Sachse	NASA Langley	N/A
	Hanwant Singh	NASA Ames	N/A
	A. L. Torres	NASA Wallops	N/A
	S. C. Wofsy	Harvard	NAG-1-55
Surface	M. O. Andreae	Florida State U	NAG-1-588
	David Fitzjarrald	State U of New York-Albany	NAG-1-692
	R. C. Harriss	U of New Hampshire	NAG-1-1014
	C. L. Martin	Simpson Weather Assoc	N/A
	R. A. Rasmussen	Oregon Grad Ctr	N/A
	Steven Wofsy	Harvard U	NAG-1-55
AGE	R. C. Harriss	U of New	N/A



Area	Investigator	Organization	Grant
		Hampshire	
	P. A. Matson	NASA Ames	N/A
	J. E. Richey	U of Washington	N/A
	P. Vitousek	Stanford U	N/A

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1. Collection Overview

a. Collection Contents

Aircraft data sets are available for each investigation for each flight. Ground-based data are usually available on a daily basis. Airborne measurements were typically obtained at constant altitude during transit flights (i.e. "survey" flights), and over multiple altitudes during flight from the intensive sites. Flight missions were conducted during ABLE 2B from April 1 through May 13, 1987. Section 4.b lists the flight dates. The duration, altitude range, ascent and descent rate, and flight path for each mission varied depending on mission objectives and environmental (weather) conditions. Ground-based measurements were made at sites shown in Harriss et al., [1990]. The automated ground sites provided daily measurements during the time frame when airborne measurements were being made and weekly averaged samples before and after. Further information about the measurement region and time frame may be found in the Journal of Geophysical Research, Vol.95, No.D10, September 20, 1990.

Data Set Introduction

This data set contains all of the data submitted to the GTE data archive by the ABLE 2B investigators listed in Section 1.d. Included are the atmospheric chemistry, meteorological and navigational data recorded aboard the NASA Wallops Electra airborne laboratory, data obtained from surface level sites, sonde and balloon data and all of the merged data sets. Note that the ASDC data link points the user back to the [GTE data archive](#) to obtain the data.

Summary of Parameters

The atmospheric species and other parameters measured are listed in Section 4.c. Also listed for each are the name and affiliation of the principal investigator.

b. Related Data Collections

ABLE 2B investigators have individually reported the results of their investigations in the Journal of Geophysical Research, Vol. 95, No. D10, September 20, 1990.

There are data sets available from the Langley ASDC for 13 other GTE missions conducted from 1983 to 2001. See the [GTE home page](#) and/or the [ASDC GTE Data Table](#) for a description of the available data.

c. Title of Investigation



d. Investigator Name and Title

If the person is known to be retired, deceased or no longer at the organization originally responsible for the experiment, it is noted and the contact information may be omitted. The contact information provided was current during the mission, but may no longer be current.

Electra Investigators

Investigator Area	Investigator Information
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Airborne Meteorological/Navigation Data	S. M. Beck (no longer at LaRC) NASA Langley Research Center
Aerosol and Ozone Profiles	Edward V. Browell Mail Stop 401A NASA Langley Research Center Hampton VA 23681-0001 Telephone: 757-864-1273 Fax: 757-864-7790 E-mail: edward.v.browell@nasa.gov
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Aerosol Composition	P. Artaxo Netto University of Sao Paulo Instituto de Fisica Caixa Postal 66318 CEP 05389-970, Sao Paulo SP Brazil Telephone: 55-11-818-7016 Fax: 55-11-818-6749
Radon 222	D. J. R. Nordemann INPE Departamento de Meteorologia C. P. 515, 12.200 San Jose Dos Campos SP Brazil Telephone: 55-123-229977 Fax: 55-123-21-8743
Hydrocarbons and Isoprene	R. A. Rasmussen Oregon Graduate Center Department of Environmental Science 19600 N. W. Von Neuman Drive Beverton OR 97006-1999 E-mail: rrasmus@ese.ogi.edu
Turbulent Flux of CO, O ₃ , H ₂ O	John Ritter (no longer at LaRC)
Carbon Monoxide, Methane	Glen W. Sachse MS 483 NASA Langley Research Center Hampton VA 23681-0001 Telephone: 757-864-1566 Fax: 757-864-8818



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Carbon Dioxide	S. C. Wofsy Center for Earth and Planetary Physics Pierce Hall 29 Oxford Street Harvard University Cambridge MA 02138 Telephone: 617-495-4566 E-mail: swofsy@seas.harvard.edu

Ground-based Measurements Investigators

Investigator Area	Investigator Information
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Rainfall	E. M. C. Cutrim Federal University of Para (Later address) Western Michigan University Geology Department Kalamazoo MI 49008 Telephone: 608-263-3434 Fax: 608-262-5974 E-mail: elen.cutrim@wmich.edu
Eddy Heat and Moisture Fluxes	D. R. Fitzjarrald Atmospheric Sciences Research Center SUNY-Albany 100 Fuller Road Albany NY 12005 Telephone: 518-442-3838 Fax: 518-442-3867 E-mail: fitz@asrc.cestm.albany.edu
Meteorological Conditions	M. Garstang University of Virginia Department of Environmental Sciences



	Clark Hall Charlottesville VA 22903 Telephone: 804-979-3571 Fax: 804-979-5599 E-mail: mxg@thunder.swa.com
Ozone and Carbon Monoxide	V. W. J. H. Kirchhoff Instituto Nacional de Pesquisas Espaciais C. P. 515 12201 Sao Jose dos Campos Sao Paulo, Brazil Telephone: (55) 123-41-8977 Fax: (55) 123-21-8743
Wind and Temperature Profiles, Radiation and Rainfall	L. C. B. Molion INPE (Later address) Federal University of Alagoas Cidade Universitaria - BR 101 KM. 14 57.072-970 Macio Alagoas Brazil Telephone: 55-82-322-2277 ext. 2060 Fax: 55-82-322-2345
Water Chemistry	L. M. Moreira-Nordemann INPE
Aerosols	P. Artaxo Netto University of Sao Paulo (See prior above entry)
Soil Composition	A. Nobre INPA/CPCA Al. Cosme Ferreira, 1756 Manaus AM 69083-000 Brazil Telephone: 55-926-43-3153 Fax: 55-926-43-3095
Temperature and Water Vapor	B. A. Nobre INPE
Radon 222	D. J. R. Nordemann INPE (See prior above listing)
Solar Radiation	H. S. Pinheiro Federal University of Para
Hydrocarbons and Isoprene	R. A. Rasmussen Oregon Graduate Center (See prior above listing)
Satellite Imagery	A. W. Setzer University of Sao Paulo (Later address) INPE Department of Meteorologia C.P. 515, 12.201 Sao Jose Dos Campos Sao Paulo Brazil Telephone: 011-55-123-22-9977 Fax: 301-286-9200
Organic Acids, Sulfur Species, Aerosol Composition	R. W. Talbot (See above prior entry)
Eddy Correlation and Soil Flux and In situ Profiles	S. C. Wofsy (See above prior entry)

AGE Program Investigators

Investigator Area	Investigator Information
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Methane	R. C. Harriss Institute for the Study of Earth, Oceans and Space Science and Engineering Research Center University of New Hampshire 929 College Road Durham NH Telephone: 603-862-3875
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e. Technical Contact(s)

The following persons have more specialized knowledge about the data in the data sets or in their field or general knowledge about the mission, its execution and the data sets.

Investigator or Knowledge Area	Investigator and Contact Information
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Aerosol Composition, Organic Acids, CO ₂	R. C. Harriss (See prior above listing)
ABLE 2B Mission Scientist and Associate Mission Scientists	<ul style="list-style-type: none"> • R. C. Harriss (See prior listing above) • S. C. Wofsy (See prior listing above) • M. Garstang (See prior listing above) • L. C. B. Molion (See prior listing above)
ABLE 3B Program Manager	Robert J. McNeal (retired) NASA Headquarters
ABLE 2B Project Manager	James M. Hoell, Jr. (retired) NASA Langley Research Center
Brazilian Project Coordinator	J. R. B. Coelho Departamento de Meteorologia INPE C. P. 515 12.200 - Sao Jose Dos - SP Brazil
ABLE 2B Mission Meteorologist	M. Garstang (See prior above listing)
ABLE 2B Expedition Manager	Richard J. Bendura (retired) NASA Langley Research Center
Aircraft Operations and Experiments Manager	S. M. Beck (See prior above listing)
Electra Mission Manager	R. L. Navarro (retired) NASA Wallops
Ground Operations and Data Manager	Joseph W. Drewry (retired) NASA Langley Research Center
AGE Coordinator	P. A. Matson NASA ARC



2. APPLICATIONS AND DERIVATION

Potential usage and applications of the described data sets can be seen in the articles that comprise the Journal of Geophysical Research ABLE 2B Special Section (Vol.95, No. D10 September 30, 1990) and the 1988 Spring AGU Meeting.

a. Calculated Variables

For convenience of the users, the calculated variables below are provided.

Mach Number, M:

$$M = \sqrt{5 * \left[\left(\frac{Q_c}{P_s} + 1 \right)^{\frac{2\gamma}{\gamma-1}} - 1 \right]}$$

M = Mach Number
Ps = Static Pressure
Qc = Differential Pressure

Static Air Temperature, Ts:

$$T_s (^{\circ}\text{K}) = \frac{T_T}{\left[1 + M^2 * \left(\frac{\gamma-1}{2} \right) \right]}$$

T_s = Static Air Temperature (°K)
T_T = Total Air Temperature (°K)
γ = 1.4, ratio of specific heat of air at constant pressure and volume

True Air Speed, TAS:

$$\text{TAS(}^{\circ}\text{kts)} = M * a = M * 38.96695 * \sqrt{T_s}$$

TAS = True Air Speed (knots)
T_s = Static Air Temperature (°K)
M = Mach Number
a = Speed of Sound

Potential Temperature, θ:

$$\theta (^{\circ}\text{K}) = T_s * \left(\frac{1000}{P_s} \right)^{0.2857142}$$

θ = Potential Temperature (°K)
T_s = Static Air Temperature (°K)
P_s = Static Pressure (mb)

Vapor Pressure, e :

$$e_{\text{water}} (\text{mb}) = [1.0007 + (3.46 * 10^{-6} * P_s)] * 6.1121 * \text{EXP}[17.502 * T / (240.97 + T)]$$

$$e_{\text{ice}} (\text{mb}) = [1.0003 + (4.18 * 10^{-6} * P_s)] * 6.1115 * \text{EXP}[22.452 * T / (272.55 + T)]$$

e = Partial Pressure of Water Vapor (mb)
P_s = Static Pressure (mb)
T = Static Air Temperature (°C) for Saturation Vapor Pressure
or
T = Dew/Frost Point (°C) for Partial Pressure of Water Vapor

Note:

1. ProjDP of zero or greater should be used to derive the partial pressure of water vapor w.r.t water (e_{water}) and the ProjDP less than zero should be used to derive the partial pressure of water vapor w.r.t ice (e_{ice}).
2. StatTempDegC and ProjDP parameters recorded in the P-3B data set are substituted to calculate saturation vapor pressure and partial pressure of water vapor, respectively.



3. TSDEGC and ProjDP parameters recorded in the DC-8 data set are substituted to calculate saturation vapor pressure and partial pressure of water vapor, respectively. Also notice in the DC-8 data set there is a redundant static air temperature measurement, TSCALC, which is calculated by DADS. Although TSDEGC and TSCALC track closely they can diverge by $\sim 1^\circ$ at the low and high ends of the measurement range.

Specific Humidity, q:

$$q(\text{g/kg}) = \frac{0.622 \cdot 10^3 \cdot e}{(P_s - 0.377e)} \quad q(\text{ppmw}) = \frac{0.622 \cdot 10^6 \cdot e}{(P_s - 0.377e)}$$

Mixing Ratio, r:

$$r(\text{g/kg}) = \frac{0.622 \cdot 10^3 \cdot e}{(P_s - e)} \quad r(\text{ppmw}) = \frac{0.622 \cdot 10^6 \cdot e}{(P_s - e)}$$

Note:

ppmv = 1.608 * ppmw

ppmw = 0.622 * ppmv

Relative Humidity, %:

w.r.t. water,

$$RH_{\text{water}} = \frac{e_{\text{water}}}{e_{s_{\text{water}}}} \cdot 100$$

w.r.t. ice,

$$RH_{\text{ice}} = \frac{e_{\text{ice}}}{e_{s_{\text{ice}}}} \cdot 100$$

b. Graphs and Plots:

Interested readers should see the Journal of Geophysical Research, Vol. 95, No. D10, September 20, 1990, and documents referenced therein, for plots and the results of analysis of data.

3. DATA DESCRIPTION AND ACCESS

a. Format

See the [GTE Data Format Document](#)

b. Data Organization

Granularity

A general description of data granularity as it applies to the IMS appears in the [EOSDIS Glossary](#). Aircraft data sets are available for each investigation for each flight. Surface level data are available on a daily basis.

c. Data Collection Status and Plans

All data available for the ABLE 2B mission are listed in the ABLE 2B Data Archive Table. No additional data products relevant to ABLE 2B are anticipated.

ABLE 2-B Data Archive

PI	Technique	Platform	Species
M. Andreae	Traps	Electra	DMS
M. Andreae	Traps	Electra	SO ₂
G. Gregory	Chemiluminescence	Electra	Ozone, coarse & fine aerosols
D. Nordeman E. Pereira	Grab Samples	Electra	Radon
Project	-----	Electra	latitude, longitude, ground speed,

			ground track, wind speed, wind direction, surface temp, static pressure, differential pressure, DP300, PRT-5, UVZ, UVN, barometric altitude, static air temperature, true air speed, pitch, roll, yaw
G. Sachse	IR Laser Differential Absorption	Electra	CO, O ₃
G. Sachse	IR Laser Differential Absorption	Electra	CO, O ₃
G. Sachse	IR Laser Differential Absorption	Electra	CO, O ₃
H. Singh	Electron Capture GC	Electra	PAN, C ₂ CL ₄
R. Talbot	Filters	Electra	POC, fine SO ₄ , coarse SO ₄ , fine NO ₃ , coarse NO ₃ , fine Cl, coarse Cl, fine C ₂ O ₄ , coarse C ₂ O ₄ , fine HCOO, coarse HCOO, fine CH ₃ COO, coarse CH ₃ COO, fine CH ₃ COCOO, coarse CH ₃ COCOO, fine CH ₃ SO ₃ , coarse CH ₃ SO ₃ , fine Na, coarse Na, fine NH ₄ , coarse NH ₄ , fine K, coarse K
S. Wofsy	IR Absorption	Electra	CO ₂
M. Andreae	Event Collection	Ground	Rain Water Chemistry (formate, acetate, pyruvate, MSA, chloride, nitrate, sulfate, oxalate, sodium, ammonium, potassium, H ⁺ , Mg, Ca, pH, DOC
C. Nobre	Rawinsonde	Ground	Temp. RH, WS, WD
S. Wofsy	Grab Samples	Ground	CO ₂
S. Wofsy	Grab Samples	Ground	O ₃
S. Wofsy	Grab Samples	Ground	NO
S. Wofsy	Grab Samples	Ground	NO _y
S. Wofsy	Grab Samples	Ground	O ₃ Flux
S. Wofsy	Grab Samples	Ground	CO ₂ Flux
D. Fitzgerald	Ground based samples	Ground	CO ₂ , O ₃ , wind speed, wind direction, vertical velocity, temperature, humidity
M. Garstang	Rawinsonde (Carapana)	Ground	Altitude, temperature, relative humidity, wind speed, wind direction, pressure
M. Garstang	Rawinsonde (Ducke)	Ground	Altitude, temperature, relative humidity, wind speed, wind direction, pressure
M. Garstang	Rawinsonde (Embrapa)	Ground	Altitude, temperature, relative humidity, wind speed, wind direction, pressure
M. Garstang	Tethered Balloon (Carapana)	Ground	Press., Altitude
M. Garstang	Tethered Balloon (Ducke)	Ground	Press., Altitude
M. Garstang	Tethered Balloon (Embrapa)	Ground	Press., Altitude

d. Data Access

The ABLE 2B data are available online through the [GTE Data Archive](#) or on a CDROM which can be ordered online through the [LaRC ASDC](#).

e. Data Archive Center

The Atmospheric Science Data Center at NASA's Langley Research Center.



Contacts for Data Center or Data Access Information:

User and Data Services Group
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f. How to Cite the Data Collection

Publication of a portion(s) of the data archive should acknowledge the principal investigator(s) responsible for the data by referencing the appropriate manuscript in the Journal of Geophysical Research, Vol. 95, No. D10, September 20, 1990.

4. DATA CHARACTERISTICS:

a. Study Area

Airborne measurements were made over the NASA Wallops Electra airborne laboratory. A more detailed description of the surface level environmental characteristics for the experiment region is provided in the individual papers for each investigation included in the Journal of Geophysical Research, Vol. 95, No. D10, September 20, 1990. Additional information may be found in other publications authored by the principal investigators or on the [GTE home page](#).

Spatial Coverage

Flight missions were conducted during April and May 1987. The duration, altitude range, ascent and descent rate, and flight path of each mission varied depending on mission objective and environmental (weather) conditions. The nominal air speed ranged from 298 knots (approximately 342 mph) at 6.13 km altitude to 213 knots (approximately 245 mph) at 0.09 km.

Data Set Name	Min Lat	Max Lat	Min Lon	Max Lon
GTE_A2B_Elec_Chem	84.07S	37.53N	81.46W	31.29W
GTE_A2B_Tower	2.57S	2.93S	59.66W	60.02W
GTE_A2B_Rawinsondes	1.38S	12.73S	48.48W	61.00W
GTE_A2B_Balloons	2.57S	2.93S	59.66W	60.02W
GTE_A2B_Merged_Data	84.07S	37.53N	81.46W	31.29W

Spatial and Temporal Resolution

Resolution varies for each measurement. See the individual headers associated with each data file for specific information.

Grid Description

No data gridding or binning of data to a geographic grid occurred during data processing.



b. Temporal Coverage

ABLE 2B aircraft missions were conducted from April 1 through May 13, 1987.

Data Set Name	Begin Date	End Date
GTE_A2B_Elec_Chem	4/1/87	5/13/87
GTE_A2B_Tower	4/4/87	5/9/87
GTE_A2B_Rawinsondes	4/13/87	5/13/87
GTE_A2B_Balloons	4/13/87	5/13/87
GTE_A2B_Merged_Data	4/1/87	5/13/87

c. Parameter or Variable

Not all of the parameters are in each data set granule. Also, the ranges vary between data sets and between granules within each data set. Species measured are given in Harriss et al., [1990].

Parameter Description

The variables measured are standard atmospheric chemical and meteorological species requiring no further elaboration here.

Unit of Measurement

The units of measure vary widely depending on species and measurement environment and are addressed in the individual papers for each investigation included in the Journal of Geophysical Research, Vol. 95, No. D10, September 20, 1990.

Parameter Source

The instruments used in making the measurements are listed in the individual papers for each investigation included in the Journal of Geophysical Research, Vol. 95, No. D10, September 20, 1990.

Parameter Range

The ranges of data vary widely depending on species and measurement environment and are addressed in the individual papers for each investigation included in the Journal of Geophysical Research, Vol. 95, No. D10, September 20, 1990.

Sample Data Record

The [GTE Data Format Document](#) contains examples of each data set type.

d. Error Sources

The sources of error vary depending on species and measurement environment and are addressed in the papers included in the ABLE 2B special issue of the Journal of Geophysical Research, Vol. 95, No. D10, September 20, 1990, and/or papers referenced in that publication and readme files and/or header records associated with each data file.

5. USAGE GUIDANCE

a. Known Problems with the Data

None reported for the current archive version. See the readme files and header records included with each data set for information provided by the responsible investigator.

b. Future Modifications and Plans

The data sets submitted to the ASDC are considered final and no further updates are planned. However, modifications will be considered if requested by the investigators or otherwise justified.

6. ACQUISITION MATERIALS AND METHODS



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<http://eosweb.larc.nasa.gov>



7. REFERENCES

1. AGU Spring Meeting, Baltimore, MD, 16-20 May 1988.
2. ABLE 2B Special Section, Journal of Geophysical Research, Vol. 95, No. D10, September 20, 1990.
3. [GTE Bibliography](#)
4. Harriss, R. C., M. Garstang, S. C. Wofsy, S. M. Beck, R. J. Bendura, J. R. B. Coelho, J. W. Drewry, J. M. Hoell, P. A. Matson, R. J. McNeal, L. C. B. Molion, R. L. Navarro, V. E. Rabine, and R. L. Snell, The Amazon Boundary Layer Experiment: Wet Season 1987, J. Geophys. Res., Vol. 95, No. D10, 16721-16736, 20 September, 1990.

8. ACRONYMS

[EOSDIS Acronyms](#) (PDF)

ABLE 2B - Amazon Boundary Layer Expedition - Wet Season

AGE - Amazon Ground Emissions Program

AGU - American Geophysical Union

ASDC - Atmospheric Science Data Center

CPCA - Coordenacao De Pesquisas Em Ciencias Agromonicas (Department of Agronomic Sciences)

DADS - Data Acquisition and Display System

EOSDIS - Earth Observing System Distributed Information System

GTE - Global Tropospheric Experiment

IMS - Information Management System

INPA - Instituto de Pesquisas de Amozonia (National Research Institute for Amazonia)

INPE - Instituto Nacional de Pesquisas Espaciais (National Institute for Space Research)

ISEOS - Institute for the Study of Earth, Oceans and Space

LaRC - NASA Langley Research Center

NASA - National Aeronautics and Space Administration

ProjDP - Project Dew Point

TSCALC - Static temperature, calculated by DADS

TSDEGC - Static temperature, measured directly, in Celsius

9. Document Information:

- **Creation Date:** November 2003
- **Revision Date:**
- **Review Date:**
- **Identification:**
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